THE DISTRIBUTION OF PETROLEUM IN VICTORIA

by

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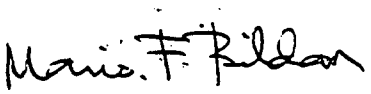
graduated 1986

A thesis submitted in fulfilment of one-quarter of the requirements for the degree of Master of Transport Economics in the University of Tasmania, under arrangement with the Department of Civil Engineering at Monash University

February, 1985

STATEMENT

This thesis contains no material which has been accepted for the award of any other degree in any University. To the best of my knowledge and belief, the thesis contains no material previously published or written by any other person, except where due reference is given in the text.



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ACKNOWLEDGMENTS

I would like to record appreciation of the efforts and support of all who assisted me, particularly to:

1) Prof. Ken W. Ogden, my supervisor at Monash University, whose guidance has not only enhanced the technical merit of this work but has also influenced my professional attitudes and goals.

2) My wife, Emily, for her general encouragement to complete this work sooner.

3) And most especially to the Almighty God who led me in this path.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The location and development of cities and industries are closely related to the availability of raw materials and other inputs of production, and to the presence of people. Where there is movement of people, and production and transport of goods and materials, there are petroleum products consumed.

The demand for petroleum transport is a derived demand, since movement of petroleum products results from decisions made in other sections of the economy concerning production, consumption and sales of goods and services. These decisions may have little to do with petroleum transport, but lead to the demand for petroleum and hence for petroleum transport.

Petroleum products and petroleum transport are related because anything that affects the demand for petroleum products also affects the demand for petroleum transport. However, the demand for petroleum transport may be affected without affecting the demand for

the petroleum products themselves, since technological, regulatory and other charges may affect the way in which the distribution task is carried out. Because of the nature of demand of petroleum transport, carriers must be sensitive to conditions that prevail in the markets for petroleum products to accurately forecast their demand picture and to plan their marketing strategies.

1.2 OBJECTIVE AND SCOPE OF THE STUDY

The object of this thesis is to analyse the scale and pattern of movements of petroleum products in Victoria and in particular the role of the Railways (State Transport Authority) in their transport. In seeking to analyse this, the thesis examines three related areas to the transport of petroleum products: transport supply and demand, distribution of petroleum products and the conditions of regulations.

The demand for petroleum transport in Victoria is discussed in Chapter 2. This includes current consumption patterns, the estimation of petroleum product consumption and dispersion of petroleum users, incidence of freight rates, and petroleum demand forecasts.

The distribution of petroleum in Victoria is discussed in Chapter 3. The chapter notes the supply of petroleum transport, role of the available modes of petroleum transport and the regulatory environment controlling the supply of petroleum transport.

Chapter 4 assesses the competitive situation for the Railways in the petroleum transport market, and the impact of the government regulations on petroleum transport in Victoria.

1.3 ASSUMPTIONS AND DEFINITION OF TERMS

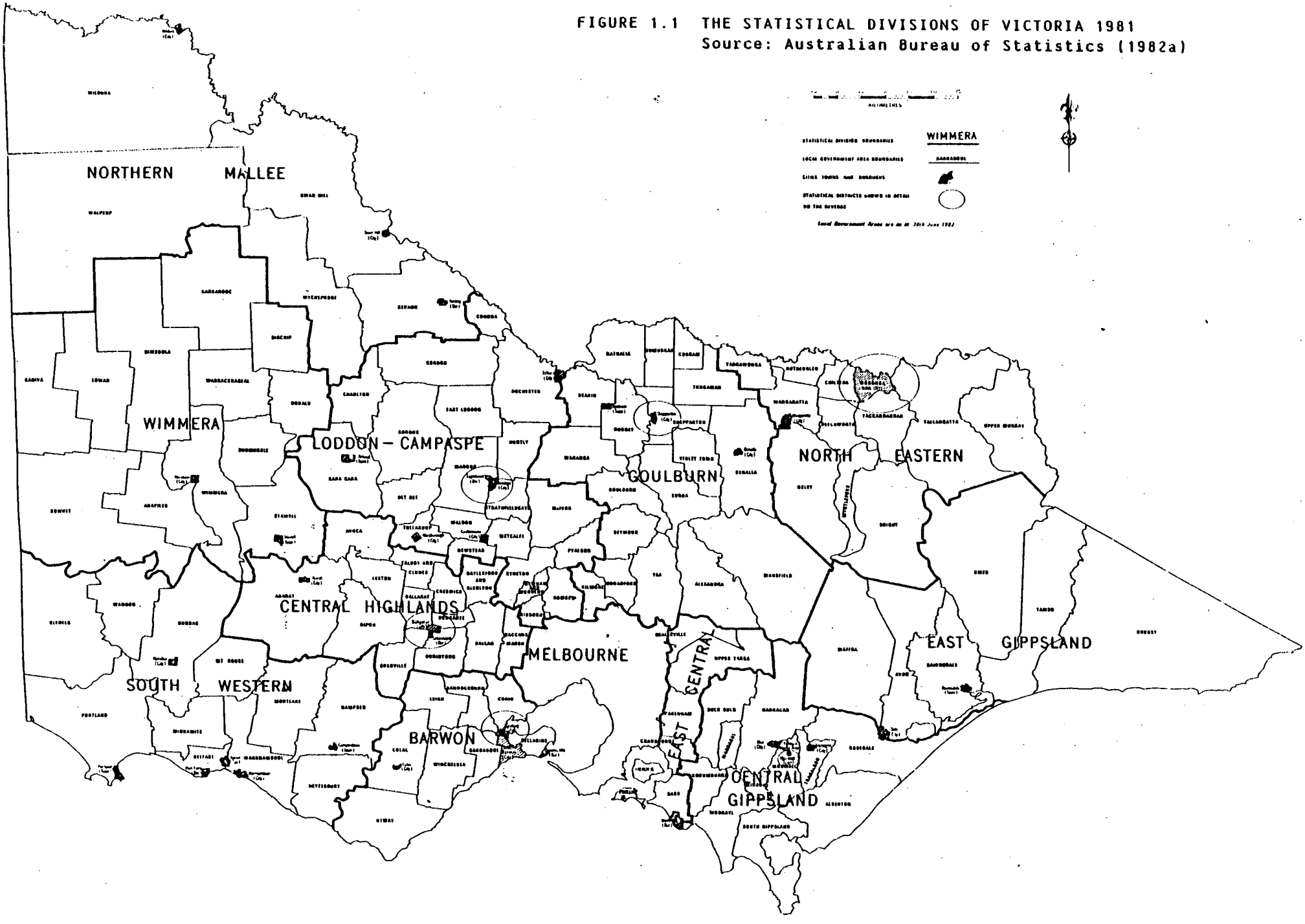
There are four assumptions made in this study. They are:

Assumption 1: The demand of petroleum products is equal, over a period, to the consumption of petroleum products.

Assumption 2: Consumption of petroleum products in Victoria refers to the quantity of petroleum products consumed in the state marketing area of Victoria. The state marketing area of Victoria includes the whole of the political area less the Murrayville district but plus the Riverina district of New South Wales; this area is that defined as the Victorian marketing area in the Australian Institute of Petroleum publication: "Oil and Australia: the Figures Behind the Facts, 1981".

Assumption 3: The state of Victoria is subdivided into twelve regions consistent with the Australian Bureau of Statistics' statistical divisions. Consumption of petroleum products in the towns and cities inside a particular statistical region are added together and they are taken as the consumption of that particular statistical region. Figure 1.1 shows the map of Victoria illustrating its statistical boundaries as of June 1981.

FIGURE 1.1 THE STATISTICAL DIVISIONS OF VICTORIA 1981
Source: Australian Bureau of Statistics (1982a)



Assumption 4: The total consumption of petroleum products is proportionally distributed to the twelve statistical regions according to the energy requirements of various end users. In this thesis, consumers of petroleum products are grouped into three end user categories, namely: Population Related Activities (P.R.A.), Agriculture, and Manufacturing (see Section 2.2). The locations of these three groups of end users provide information on the distribution of petroleum products and are used to establish the consumption in each statistical region.

The consumption of petroleum in Population Related Activities category in each statistical region is assumed to be proportionally distributed according to the population of Victoria. This assumes that there are no economies of scale in the utility of petroleum, i.e. that the consumption of petroleum products per capita in this category is constant throughout the marketing area of Victoria. In the absence of information indicating a variation in per capita consumption, this assumption seems reasonable.

The consumption of petroleum products in Agriculture is assumed to be proportionally distributed to the area of the land used for agricultural activities. The total quantity of petroleum products used in Agriculture in Victoria is thus assumed to be proportional to the total area of land in occupation for agricultural purposes.

The total consumption of petroleum products in Manufacturing is distributed according to the energy consumption of the manufacturing industries in each statistical region, as published by the

Australian Bureau of Statistics (1982b).

For the purpose of this study, terms used are defined as follows:

a) Oil Products : are defined as the products derived from crude oil, including crude oil, condensate and synthetic fuels derived from coal and oil shale. They consist of motor spirit, automotive distillate, fuel oil, liquified petroleum gas, aviation gasoline, power and lighting kerosene, aviation turbine fuel, heating oil, bitumen, lubricants, solvents and naphtha. Liquified petroleum gas is included in the oil products although it is also obtained with the production of natural gas.

b) Petroleum Products : are defined as the four major oil products consumed in Victoria. They are the motor spirit (MS), automotive distillate (ADO), fuel oil (FO), and liquified petroleum gas (LPG).

c) End Users : are the consumer groups as mentioned in Assumption 4. These are the three major consumer categories, namely: Population Related Activities (P.R.A.), Agriculture, and Manufacturing. The P.R.A. category is composed of the groups of small industries (i.e., Electricity, Gas, Construction, Water and other industries different from Agriculture and Manufacturing) and the Transport Industry.

d) Tank Farms : are defined as the immediate depots where oil products from the refinery are stored initially.

e) Block Trains : are defined as trains with fixed rakes of wagons operating from certain filling terminals and unloading at single discharge facilities in each centre on scheduled loading and unloading times.

CHAPTER 2

DEMAND FOR PETROLEUM TRANSPORT IN VICTORIA

2.1 OVERVIEW

The analysis of demand for petroleum transport in Victoria can be considered in three different components. First, the nature of the demand for petroleum transport, which in turn depends on:

the characteristics of petroleum;

the location of petroleum users; and

the uses to which petroleum products are put.

Second, the freight rate of petroleum transport and the ability to pass that price component to end users of petroleum.

Third, the forecast of future demand for petroleum, which then determines the forecast of requird petroleum transport.

2.2 PETROLEUM CONSUMPTION PATTERNS

Consumption patterns of petroleum products are analysed in terms of the major oil products consumed and their end users scattered around the State of Victoria.

2.2.1 Petroleum Products

The main petroleum products consumed in Victoria are Motor Spirit, Automotive Oistillate, Fuel Oil and LPG. Together, these four groups of petroleum products account for about 90% of the petroleum products consumed in Victoria. Consumption patterns for the three most recent years for which data were available are shown in Table 2.1A.

Table 2.1B has been derived from Table 2.1A to show tonnes of consumption by using the corresponding densities of each petroleum product as adopted by the Australian Institute of Petroleum. (Table 2.1C) The density of Fuel Oil used here is the average density of Fuel Oil with high sulphur and Fuel Oil with low sulphur contents. Similarly, the density of LPG is taken as the average of the densities of Propane and Butane. These averages are used to compensate for the uncertainties when the exact volume and specifications of the petroleum products consumed are not indicated. For Motor Spirit, the density of super grade (1350 litres per tonne) is adopted because almost all of the Motor Spirit consumed in Victoria in recent years has been super grade petrol.

Table 2.1B reveals that in tonnage terms, Motor Spirit consumption increased by 3.67% from 1980-81 to 1981-82, and its overall share in petroleum consumption increased from 55% in 1979-80 to 57.94% in 1981-82.

TABLE 2.1A PERCENT SHARE AND VOLUME OF ALL PETROLEUM PRODUCTS CONSUMED IN VICTORIA

Petroleum Product Category	1979-80		1980-81		1981-82	
	Megalitres	%	Megalitres	%	Megalitres	%
Motor Spirit	4141	55.00	4123	57.08	4274	57.94
Automotive Distillate	1300	17.27	1258	17.41	1292	17.52
Fuel Oil	748	9.93	634	8.78	563	7.63
LPG	359	4.77	380	5.26	472	6.40
Other	981	13.03	828	11.47	775	10.51
Total	7529	100	7223	100	7376	100

Source: Australian Institute of Petroleum (1980,81,83)

TABLE 2.1B QUANTITY OF ALL PETROLEUM PRODUCTS CONSUMED IN VICTORIA ('000 tonnes)

Petroleum Product Category	1979-80		1980-81		1981-82	
	'000 tonnes	%	'000 tonnes	%	'000 tonnes	%
Motor Spirit	5590	56.95	5566	58.78	5770	59.25
ADO	1547	15.76	1497	15.81	1537	15.78
Fuel Oil	830	8.46	704	7.43	625	6.42
LPG	661	6.73	699	7.38	868	8.91
Other	1188	12.10	1003	10.60	939	9.64
Total	9816	100	9469	100	9739	100

TABLE 2.1C DENSITY OF THE MAJOR OIL PRODUCTS IN LITRES PER TONNE

Petroleum Product Category	Range of Density	Adopted Density
Motor Spirit	1350 to 1380	1350
Automotive Distillate	1190	1190
Fuel Oil	1020 to 1110	1065
LPG	1720 to 1960	1840
Other	980 to 1440	1211

Source: Australian Institute of Petroleum (1983).

Automotive Distillate consumption initially decreased from 1979-80 to 1980-81 but increased between 1980-81 and 1981-82. Its overall share in petroleum consumption increased gradually from 1979-80 through 1981-82.

Liquified Petroleum Gas consumption steadily increased both in tonnage terms and in its overall share in petroleum consumption; while Fuel Oil consumption decreased both in tonnage terms and in its overall share in petroleum consumption over the period.

2.2.2 End Users

Information on the main end users of petroleum products are published by ABS (1982B). However in order to analyse the distribution and use of these products, it is necessary to have information on the dispersion of petroleum products by statistical divisions and by end users.

These data are not obtainable from ABS publications, but the Department of National Development and Energy (DNDE) (1981) has published forecast figures on the energy consumption of various end users. This information together with ABS data on the spatial distribution of the user groups (Section 1.3) was used to determine the distribution of petroleum products by end users. A representative illustration is presented in Appendix A in relation to how consumption of petroleum products by end users is computed, a summary of which is shown in Table 2.2A.

TABLE 2.2A CONSUMPTION OF PETROLEUM PRODUCTS BY ALL END USERS VICTORIA 1981-82

Petroleum Product Category	Consumption by End User Sector in '000 tonnes						
	Agri.	Manuf.	El,Gas	Constr.	Transport	Other	Total
Motor Spirit	-	-	-	-	5770	-	5770
ADO	562.23	0.31	-	1.08	785.25	188.13	1537
Fuel Oil	-	45.75	149.87	2.56	414.13	12.69	625
LPG	2.52	352.32	-	-	306.32	206.84	868
Total	564.75	398.38	149.87	3.64	7275.70	407.66	8800
%	6.42	4.53	1.70	0.04	82.68	4.63	100

Source: Appendix A

It is shown in Table 2.2A that in 1981-82, 82.68% of the net energy available from all petroleum products sold in Victoria was used in the transport sector, 6.42% in agriculture, 4.53% in the manufacturing sector, and other groups of small industries accounted for the remaining 6.37% of the net energy available.

Since the transport sector, agriculture and the manufacturing sector account for the 93.63% of petroleum products consumed, their relative dispersion and regional locations provide major insights into the demand for petroleum transport. However, there had been no publications, nor is there any available information, on the consumption of petroleum products by statistical divisions. For these reasons, as mentioned previously, the population distribution of Victoria, location of agricultural establishments, and the location of manufacturing industry must be analysed to provide a basis for estimating consumption of petroleum products in each statistical division.

To calculate the consumption figures in each statistical division, it is essential to classify consumers into major end user groups because the distribution of these end users by statistical division is available from various publications, e.g. the Victorian Yearbook (1983) and Australian Bureau of Statistics (1982a, 1982b).

Consumers of petroleum products were grouped, for the present study into three end user categories; Population Related Activities (P.R.A.), Agriculture, and Manufacturing. To take into account the groups of small industries, their consumption are included with the Transport Industry in the P.R.A. category. The total consumption of petroleum products in each statistical division then will be the summation of each of the petroleum products consumed by these three end user in every region.

TABLE 2.2B CONSUMPTION OF PETROLEUM PRODUCTS BY THE THREE CATEGORIES OF END USERS IN VICTORIA 1981-82

Petroleum Product Category	Consumption by End User Sector in '000 tonnes			
	P.R.A.*	Agriculture	Manufacturing	Total
Motor Spirit	5770.00	-	-	5770
ADO	974.46	562.23	0.31	1537
Fuel Oil	579.25	-	45.75	625
LPG	513.16	2.52	352.32	868
Total	7836.87	564.75	398.38	8800
%	89.05	6.42	4.53	100

* Population Related Activites which include Transport, Electric/Gas/Water, Construction and others
Source: Appendix A

Table 2.2B shows the overall distribution of petroleum products by end user. It reveals that P.R.A.'s share was 89.05%, Agriculture was 6.42% and Manufacturing was 4.53% in 1981-82. Moreover, Motor Spirit was used only by the transport sector of the P.R.A.. Automotive Distillate and L.P.G. were used by the three end user sectors, while Fuel Oil was used only by the P.R.A. and Manufacturing.

2.2.3 Population Related Activities (P.R.A.)

The distribution of petroleum consumption of the Population Related Activities is assumed to follow the distribution of the population in each statistical division as noted in Section 1.3.

TABLE 2.2C CONSUMPTION OF PETROLEUM PRODUCTS OF POPULATION RELATED ACTIVITIES 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Population*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	71.07	4101	692.55	411.67	364.70
Barwon	5.02	290	48.92	29.08	25.76
South Western	2.53	146	24.65	14.66	12.98
Central Highlands	3.03	175	29.53	17.55	15.55
Wimmera	1.39	80	13.54	8.05	7.13
Northern Mallee	1.86	107	18.12	10.77	9.54
Loddon Campaspe	3.81	220	37.13	22.07	19.55
Goulburn	3.38	195	32.94	19.58	17.34
North Eastern	2.02	116	19.68	11.70	10.37
East Gippsland	1.46	84	14.23	8.46	7.49
Central Gippsland	3.39	196	33.03	19.64	17.41
East Central	1.04	60	10.14	6.02	5.34
TOTAL	100	5770	974.46	579.25	513.16

* based on the population in each statistical division
Source: ABS, 1982A, see Appendix A

The population distribution of Victoria has the following characteristics: first, more than 71% of the state's population lives in the Melbourne region, and second; there are about a dozen widely dispersed secondary population centres of several hundred thousand people accounting for a further 30% of the state population (ABS, 1982A). The quantity of each of the petroleum products consumed by P.R.A. were subdivided into statistical divisions according to the population distribution. Table 2.2C shows the results of the computations.

Obviously, the Melbourne region consumes the greatest quantity of petroleum products because a great majority of the population of Victoria are in that statistical division.

2.2.4 Agriculture

As presented in Table 2.2B, the agricultural sector uses only Automotive Distillate and L.P.G. and its share in the entire consumption of petroleum products is 6.42%.

Agricultural establishments are scattered in the rural areas of Victoria. Northern Mallee, Wimmera and the South Western statistical divisions account for about 50% of the state's agricultural activities. (Table 2.2D)

It is necessary to take into account the land occupied for agricultural purposes because agricultural activities in Victoria are highly mechanised and they use petroleum products as input. Since agricultural activities are mechanised, it is assumed that the fuel consumption for these activities is proportional to the land in occupation for agricultural purposes as noted in Section 1.3.

TABLE 2.2D CONSUMPTION OF PETROLEUM PRODUCTS OF AGRICULTURAL ESTABLISHMENTS 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Victoria*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	1.88	-	10.57	-	0.05
Barwon	3.48	-	19.57	-	0.09
South Western	12.63	-	71.01	-	0.32
Central Highlands	6.07	-	34.13	-	0.15
Wimmera	16.83	-	94.62	-	0.42
Northern Mallee	18.21	-	102.38	-	0.46
Loddon Campaspe	11.24	-	63.19	-	0.28
Goulburn	10.49	-	58.98	-	0.26
North Eastern	5.84	-	32.83	-	0.15
East Gippsland	7.86	-	44.20	-	0.20
Central Gippsland	4.65	-	26.14	-	0.12
East Central	0.82	-	4.61	-	0.02
TOTAL	100	0	562.23	0	2.52

* from Victorian Yearbook (1983), based on the area of agricultural land used in each statistical division

Source: Appendix A

The quantity of the petroleum products consumed in Agriculture were subdivided into statistical divisions according to the percentage distribution based on the occupied area of agricultural land in each statistical division. Table 2.2D shows the distribution of agricultural activities and the estimate of consumption of petroleum products based on the occupied area of agricultural land used in each statistical division.

2.2.5 Manufacturing

It has been noted earlier in Table 2.2B that petroleum product consumption by Manufacturing in Victoria accounts for about 4.53% of state petroleum consumption. The quantity of each of these petroleum products consumed in Manufacturing were subdivided into statistical divisions according to the percentage distribution based on the amount of all petroleum products used by the manufacturing industries. Table 2.2E exhibits the distribution of the consumption of petroleum products of Manufacturing by statistical divisions.

Manufacturing industries requiring petroleum products are heavily concentrated in the Melbourne region and, to a significantly lesser extent in the South Western and Goulburn regions.

Although Victoria is a highly industrialised state, the total consumption of petroleum products in the manufacturing sector is quite low compared to the consumptions of P.R.A. and Agriculture. This is due to the fact that manufacturing industries in Victoria rely heavily on other sources of energy like electricity, furnace oil, natural gas, industrial diesel fuel and coal which are not included in the major petroleum products as listed.

TABLE 2.2E CONSUMPTION OF PETROLEUM PRODUCTS OF MANUFACTURING INDUSTRIES 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Victoria*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	56.21	-	0.174	25.72	198.04
Barwon	5.66	-	0.017	2.59	19.94
South Western	9.79	-	0.030	4.48	34.49
Central Highlands	1.88	-	0.006	0.86	6.62
Wimmera	1.23	-	0.004	0.56	4.33
Northern Mallee	2.30	-	0.007	1.05	8.10
Loddon Campaspe	5.42	-	0.017	2.48	19.10
Goulburn	9.88	-	0.031	4.52	34.81
North Eastern	1.79	-	0.006	0.82	6.32
East Gippsland	0.99	-	0.003	0.45	3.49
Central Gippsland	2.34	-	0.007	1.07	8.24
East Central	2.51	-	0.008	1.15	8.84
TOTAL	100	0	0.310	45.75	352.32

* from A.B.S. (1982b), based on the amount of all petroleum products used in the Manufacturing Industries in each statistical division.

Source: Appendix A

2.2.6 Summary

The total consumption of each petroleum product in each statistical division is taken as the sum of the quantities of that petroleum product consumed by the P.R.A., Agriculture, and Manufacturing.

TABLE 2.3 CONSUMPTION OF PETROLEUM PRODUCTS BY STATISTICAL DIVISIONS IN 1981-82 VICTORIA (in '000 TONNES)

Statistical Division of Victoria	Petroleum Products					
	MS	ADO	FO	LPG	TOTAL	%
Melbourne	4101	703.294	437.39	562.79	5804.474	65.96
Barwon	290	68.507	31.67	45.79	435.967	4.95
South Western	146	95.690	19.14	47.79	308.620	3.51
Central Highlands	175	63.666	18.41	22.32	279.396	3.17
Wimmera	80	108.164	8.61	11.88	208.654	2.37
Northern Mallee	107	120.507	11.82	18.10	257.427	2.93
Loddon Campaspe	220	100.337	24.55	38.93	383.817	4.36
Goulburn	195	91.951	24.10	52.41	363.461	4.13
North Eastern	116	52.516	12.52	16.84	197.876	2.25
East Gippsland	84	58.433	8.91	11.18	162.523	1.85
Central Gippsland	196	59.177	20.71	25.77	301.657	3.43
East Central	60	14.758	7.17	14.20	96.128	1.09
TOTAL	5770	1537	625	868	8800	100

Source: Appendix A

Table 2.3 summarises the distribution of each of the petroleum products consumed. The Table indicates that the Melbourne region accounted for about two-thirds of the total petroleum consumption in the State in 1981-1982. This region is within an 80 kilometre-radius of a refinery distribution center. The relevance of this 80 kilometre-radius will be discussed in Section 3.6.

2.3 EFFECTS OF FREIGHT RATES

A second aspect of petroleum demand concerns freight rates, and the extent to which rates are effectively paid by the end users of petroleum products.

Several publications address the question of who bears the burden of freight rates (e.g. Taplin, 1982; Wanhill, 1975; Wilson, 1980). These publications suggest that the freight rate burden depends on the supply and demand elasticities of the product itself.

The share of freight rate (between the consumers and producers) depends on the slope of supply and demand curves of that particular commodity. The slopes of supply and demand curves are derivable from their respective elasticities. Elasticities of supply and demand of petroleum products are beyond the scope of this study but some publications (Donnelly, 1982; Folie, 1977; Schou and Johnson, 1979) estimated the demand elasticity of Motor Spirit in Australia ranging from -0.02 to -0.38.

The magnitude of the share of freight cost between consumers and producers of Motor Spirit is not readily known but it appears that consumers pay a higher share of the freight cost of Motor Spirit; see Appendix B.

This finding has relevance to transport policy, because, with the oil company's share of the rate being small, and the transport costs of petroleum products being only a small proportion of total costs, cutting transport costs would not create big incentives to the oil company. An implication of this is that since consumers pay a greater share of the freight charges, the subsidy program compensates mainly the consumer for some of the total freight rates which will be paid by the consumers in the final price of the product.

In Australia, particularly in Victoria, freight costs to country areas are subsidised under the Commonwealth Petroleum Freight Subsidy Scheme (reintroduced by the Fraser Government in 1978) to make users in country areas at a lesser disadvantage than their city counterpart with respect to petroleum price. (Michael and Ogden, 1984)

The Commonwealth Petroleum Products Subsidy Scheme reimburses oil companies for some of the transport cost associated with the delivery of petroleum products to designated rural areas. The scheme reflects the policy of the Commonwealth Government to subsidise the costs of petroleum products distributed to rural areas such that the wholesale price of a product is nowhere more than a cent per litre greater than in the capital city. This is done by establishing a freight differential for each locality which is supposed to represent the cost of transport to that locality. The differential is calculated as the average of the four lowest quotes received from oil companies serving the particular locality; only certain designated cost components are permitted to be included. Payments are for transport cost only. The freight differential is derived from calculations made by the Petroleum Products Pricing

Authority based on the average of the four lowest quotes supplied by the oil companies for delivery to a specific region. The subsidy applies only to motor spirit, automotive distillate, power kerosene and lighting kerosene. It does not apply to other oil products such as industrial diesel fuel, fuel oil and lubricants.

2.4 DEMAND FORECASTS

A forecast of the demand for petroleum transport in Victoria depends on a forecast of the components of that demand. The main components of petroleum transport demand are the demand of the petroleum products themselves, their dispersion throughout Victoria, and their previous trends of consumption. A comprehensive analysis of the demand for petroleum transport would provide the base for a consistent means for forecasting the transport demand.

The Commonwealth Department of National Development and Energy (DNDE) has recently produced a comprehensive report on the future energy supply and demand in Australia. This includes projections of the demand for petroleum fuels on a statewide basis. Table 2.4 has been derived from DNDE (1981) petroleum forecast for the marketing area of Victoria.

The DNDE forecasts indicate an anticipated overall growth of 2.00% per annum. Within that, Motor Spirit is expected to decline at an average rate of 0.20% per annum, automotive distillate is expected to increase at an average rate of 2.70% per annum, while LPG is expected to have the highest average growth rate of 16.60% per annum.

TABLE 2.4 FORECAST ON CHANGES IN VOLUME OF ALL PETROLEUM PRODUCTS CONSUMED IN VICTORIA

Petroleum Products Category	Base 1980-81		Forecast 1989-90		Growth Rate Percent Per Annum
	Megalitres	%	Megalitres	%	
MS	4116.0	51.13	4064.0	39.93	-0.2
ADO	1271.0	15.79	1702.8	16.73	2.7
FO	596.1	7.41	605.6	5.95	-1.8
LPG	550.8	6.84	2080.5	20.44	16.6
Other	1515.5	18.83	1724.8	16.95	
Total	8049.4	100	10,177.7	100	2.0

Source: Department of National Development and Energy (1981).

Looking on the 1980-81 to 1981-82 consumption pattern, figures from Table 2.1A and 2.1B show quite different trends from that of the forecasts. Motor Spirit was expected to decrease at an average rate of 0.20% but actually, it increased by 3.65%. The growth of Automotive Distillate is almost equal to what was forecasted at 2.70%. Fuel Oil was forecasted to decrease by 1.80% but the actual decrease was a huge 11.22%. And the growth of L.P.G. consumption is 24.18% against a forecast figure of 16.60%. The comparisons made here are only on the basis of one year as mentioned above. These comparisons make the first year of the ten-year forecast of the DNDE on Victoria's consumption of petroleum products invalid at this stage, or it may even make the entire DNDE forecast for Victoria to be not applicable anymore with respect to the consumption of petroleum products.

CHAPTER 3

DISTRIBUTION OF PETROLEUM TRANSPORT

3.1 OVERVIEW

Petroleum products are distributed in Victoria through the combined use of pipeline, rail, road and sea transport. The distribution of petroleum transport is discussed with reference to the existing modes of transport and the requirements of regulations. The way in which these transport modes combine to supply petroleum products provides important insight into the nature of operation of the petroleum transport industry.

3.2 REFINING AND DISTRIBUTION OF PETROLEUM

In 1981, Victoria's refining capacity was about 292,000 barrels per stream day. This capacity was provided by the three refineries in Altona, Crib Point and Geelong; all of which are located on the seaboard. The location of these refineries is shown in Table 3.1. (n.b., the Crib Point Refinery has subsequently been closed)

Crude oil delivered to Westernport from the Bass Strait oilfields is transported through pipelines to the Victorian refineries. Refined products are distributed from the refineries and their associated bulk storages by pipelines, road and rail.

From the refineries, refined products pass to the 24 seaboard bulk storage installations. These installations offer a storage capacity of 3185.8 megalitres representing more than 40% of Victoria's annual consumption of petroleum products. These bulk storage installations are listed in Table 3.2.

Most of the task in the distribution of petroleum products is undertaken by the major oil companies, with several small organisations also being involved. The actual structure of the distribution system varies slightly between companies, but in general all are consistent with the outline shown in Figure 3.1. The figure shows three basic components of the distribution of petroleum products. They are as follows:

1) Movement in bulk of refined products from refineries to seaboard bulk storage installations,

2) Movement from these seaboard bulk storage installations to country depots, or direct to bulk users or retailers,

3) Movement from country depots to bulk users or retailers.

TABLE 3.1 VICTORIAN REFINING CAPACITY AS OF DECEMBER 1981

COMPANY	Location of Plant	Plant Type	Primary Processing Unit
B P Refinery (Westernport) Pty. Ltd.	Crib Point	D,R,B	60,000 b/sd 2,540,000 tonnes/yr
Petroleum Refineries (Australia) Pty. Ltd.	Altona	D,C,R,B	100,000 b/sd 4,670,000 tonnes/yr
Shell Refining (Australia) Pty. Ltd.	Geelong	D,C,R,L,B	110,000 to 132,000 b/sd 5,000,000 tonnes/yr
	Total Capacity		270,000 to 292,000 b/sd 12,210,000 tonnes/yr

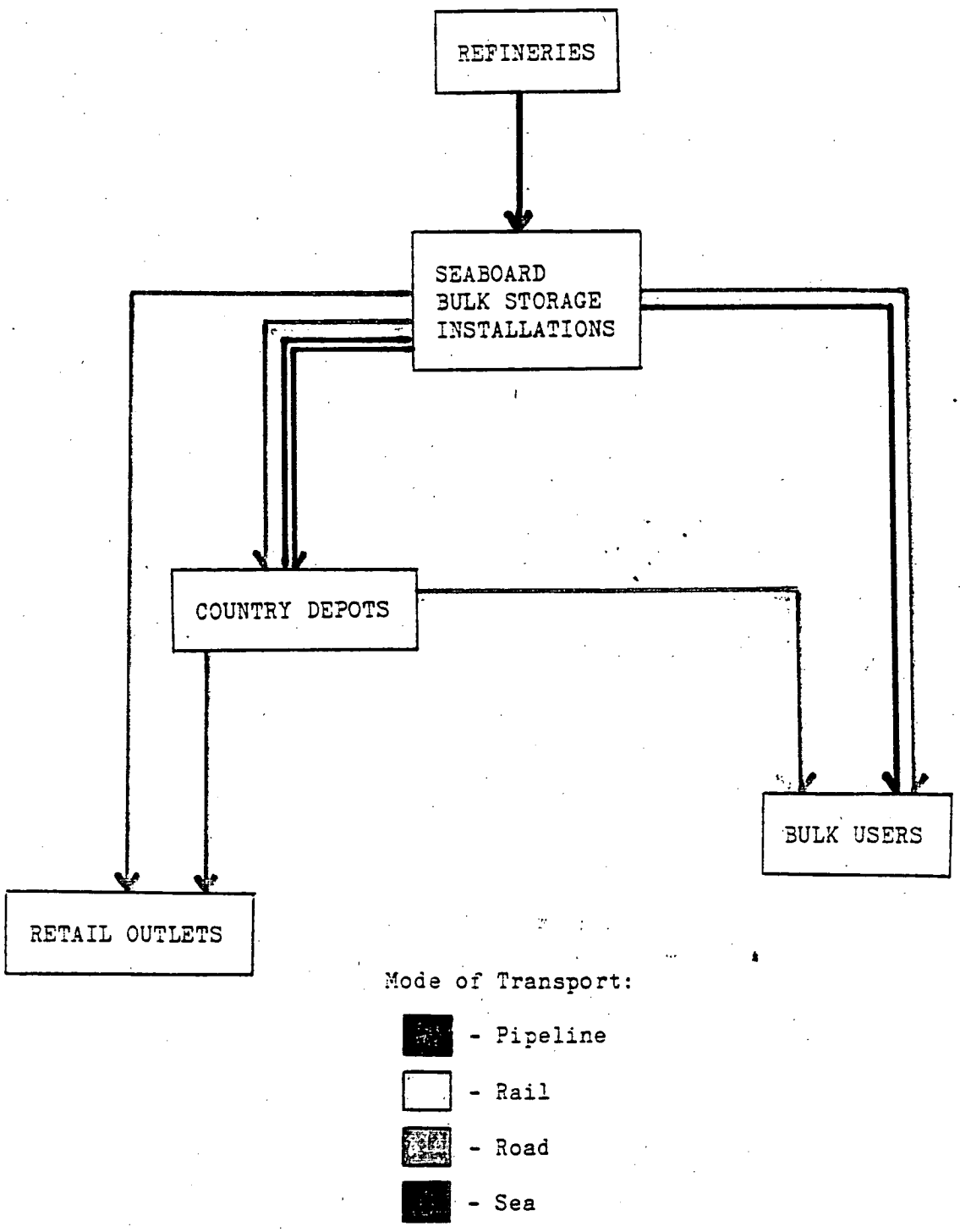
Source: Australian Institute of Petroleum (1981).
Key to Symbols: D-distillation, C-cracking, R-reforming, L-lubrication, B-bitumen, b/sd-barrels per steam day.

TABLE 3.2 SEABOARD BULK STORAGE INSTALLATIONS IN VICTORIA AS OF DECEMBER 1981

LOCATION	Installations	Capacity (ML)
Melbourne	17	1293.6
Geelong	1	1052.6
Crib Point	1	465.0
Long Island Point	1	301.9
Portland	4	72.7
TOTAL	24	3185.8

Source: Australian Institute of Petroleum (1983).

FIGURE 3.1 SCHEMATIC DIAGRAM OF PETROLEUM TRANSPORT



Rail is not involved in the first and last of these routes. The first route is the area for pipeline and/or sea transport, while the last route is for road transport. However, rail is heavily involved in the second, particularly in the North Eastern and Northern Mallee regions.

3.3 PIPELINES

Pipelines are used for transporting petroleum products between refineries, tank farms, shipping terminals, major distribution terminals and including bunkering lines. There are about 1425 km of oil product pipelines in Victoria but no details of pipeline network nor of the task which they performed have been published since 1977, (Department of Minerals and Energy, 1978).

Figure 3.2 illustrates the petroleum and natural gas pipelines and facilities in Victoria in 1977. There are five classifications of these pipelines which are basically similar according to the Department of Minerals and Energy (1978). They are:

1) The field gathering pipelines that connect separate groups of producing wells on offshore production platforms to a central field terminal from where the crude is pumped to a tank adjacent to a shipping terminal or a refinery;

2) Crude oil transmission pipelines used for conveying crude oil from treatment plants to tank farms and to a refinery over considerable distances;

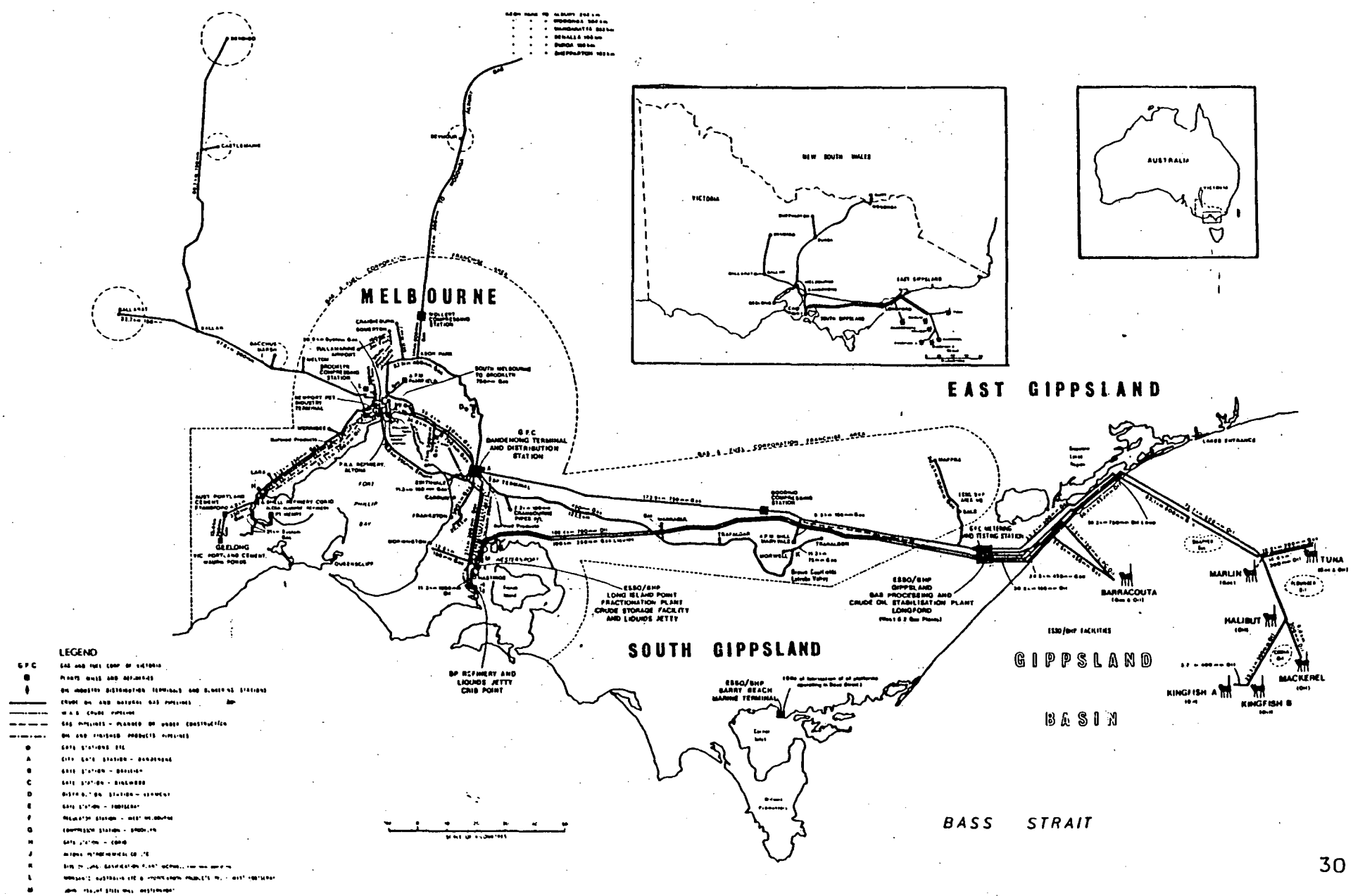


FIGURE 3.2 PETROLEUM AND NATURAL GAS PIPELINES AND FACILITIES IN VICTORIA, 1977
Source: Department of Minerals and Energy (1978)

3) Refined products transmission pipelines used for conveying wholly or partially refined products between refineries, tank farms, shipping terminals and major distribution terminals and bunkering lines;

4) Transfer lines within refineries, plants, distribution terminals, processing plants and wharf areas; and

5) the LPG and ethane gas pipelines.

For the purpose of this study, only the transmission pipelines for the refined products are taken into account for the reason that these products are also transported in any or a combination of the other available modes of petroleum transport, road, rail and sea.

Four major pipelines are used for refined products. They are the two pipelines between Geelong and Altona, one from Altona to Somerton, and one from Crib Point to Dandenong. These four major pipelines are briefly described below:

1) Shell Geelong Refinery, Corio to Newport Distribution Terminal. This pipeline is owned and operated by the Shell company. It is 53.1 km long and has 200 mm nominal diameter. It conveys white refined products (Motor Spirit, aviation jet fuel, kerosene, Automotive Distillate, etc.) from the refinery operated by Shell Refining (Australia) Pty. Ltd. at Corio to the Shell company's tank farm and distribution terminal at Newport near the mouth of the Yarra River, Melbourne.

2) Shell Geelong Refinery, Corio to Newport Distribution Terminal. This pipeline is owned and operated by the Shell company. It is 56.3 km long and has 200 mm nominal diameter. It conveys black refined products (Fuel Oil, furnace oil, etc.) from the refinery operated by Shell Refining (Australia) Pty. Ltd. at Corio to the Shell company's tank farm and distribution terminal at Newport.

3) P.R.A. Refinery, Altona to Gellibrand Pier, Williamstown and Mobil Terminal, Yarraville. This system of pipelines 11.6 km long and 150 mm nominal diameter is owned and operated by Petroleum Refineries (Australia) Pty. Ltd. It conveys refined products between the three areas mentioned.

4) BP Refinery, Crib Point to BP Depot, Dandenong. This pipeline is owned and operated by BP Australia Ltd. It is 37.4 km and has 200 mm nominal diameter. It conveys refined products from the refinery operated by BP Refinery (Westernport) Pty. Ltd. at Crib Point, about 77 km south-east of Melbourne, to the BP company's tank farm and distribution terminal at Dandenong.

LPG is also conveyed through pipelines from refineries to the distribution terminals. There are 7 LPG and ethane gas pipelines with a total length of 328.85 km serving this purpose.

3.4 ROAD AND RAIL TRANSPORT

Refineries convey their refined products by pipelines to their tank farms for subsequent road or rail transfer. Most of the Melbourne, Barwon, and East Central regions are supplied largely by road transport; together, their combined consumption is 72% of the entire petroleum consumption of Victoria (see Table 2.3). As noted earlier in Section 2.2, these markets are within 80 km of a refinery distribution point. The remainder of the market out of these regions is supplied partly by road and partly by rail.

According to the submission made by the Australian Institute of Petroleum to the Victorian Transport Study (V.T.S.) in 1980, there were about 2,500 road vehicles in Victoria involved in the transport of petroleum products. A large majority of these vehicles operate in, or close to, the metropolitan area. Road transport is used primarily to supply depots not served by rail. Road transport allows complete flexibility of operation with direct delivery from the terminal to the final customer which in some instances eliminates double handling of the product.

There are no data available on the volume of petroleum products transported by road tankers. However, their share of the petroleum transport to each statistical division of Victoria can be calculated, provided that the consumption of petroleum products in each statistical division and the volume hauled by all other modes of petroleum transport are known. This analysis is presented in Chapter 4.

TABLE 3.3 RAIL'S TRAFFIC OF PETROLEUM RELATED TO TOTAL CONSUMPTION

YEAR	Total Consumption ('000 tonnes)	Total Rail* Delivery ('000 tonnes)	Rail's Traffic as a Percentage of Consumption
1978-79	9630	388	4.03
1979-80	9816	341	3.47
1980-81	9469	383	4.04
1981-82	9739	400	4.11

* Source: Victorian Yearbook (1983).

In 1980, there were 227 inland bulk petroleum depots in Victoria, with a storage capacity for a minimum of 54000 litres for each main products (V.T.S., 1980). Only 102 of them were equipped to receive products by rail. Even though many of the depots are located within towns which have other petroleum depots served by rail, they do not enjoy the same access because of different ownership. These depots are distributed all over the twelve statistical divisions of Victoria.

Table 3.3 sets out the volume of rail traffic related to total petroleum product consumption in Victoria. It can be used to give a broad estimate of rail's mode share. It indicates that in recent years, about 4% of the consumed oil products were delivered by rail. (This figure will even decrease further when the volume of oil products for interstate deliveries are deducted -see Section 4.3.)

This low volume delivered must be seen in the light of the fact that about 71.07% of the Victoria's population and 56.21% of the manufacturing industries are within the 80 km of a refinery distribution point. Chapter 4 will present more details concerning rail distribution of petroleum.

3.5 SEA TRANSPORT

Sea transport statistics, published by the Department of Transport as "Port Authority Cargo Movements" provide details of petroleum products transported by sea in Victoria. Table 3.4 shows that sea transport is used to carry some oil products to Geelong and Westernport, and significant deliveries to Portland.

TABLE 3.4 MOVEMENT OF ALL PETROLEUM PRODUCTS BY SEA IN VICTORIA 1981-82 ('000 TONNES)

ORIGIN	DESTINATION		
	Geelong	Portland	Westernport
Melbourne	-	38	-
Geelong	-	135	15
Westernport	15	-	-
Total	15	173	15

Source: Department of Transport (1983).

The Table shows that Portland received substantial deliveries of oil products by sea. Portland is one of the major distribution centres for petroleum products in Victoria with seaboard bulk storage installations (see Table 3.2). The volume of demand for oil products in Portland and its distance from the petroleum production centres of Victoria provide a competitive edge for sea transport for petroleum products against road and rail transport to this region.

3.6 REGULATORY ENVIRONMENT

The 1980 Transport (Deregulation) Act (No. 9511) regulates the transport of petroleum products subject to regulations concerning safety and a level of ministerial control. Sections 55 and 56 of the Act empowers the Minister of Transport to grant permits which exempt specific vehicles from the general restraints. In August 1983, the Minister of Transport defined the policy in relation to the transport of bulk petroleum products. The policy states that where practicable, the use of the railways should be encouraged for the transport of bulk petroleum products beyond an eighty kilometre radius from the place of consignment. The policy does not absolutely require that petroleum products movement by road are restricted to a maximum journey of 80 kilometres. Certain movements by road are permitted under the Act, namely; to areas not served by rail and to areas served by rail where a permit is issued under special circumstances.

There are some exceptions to the issuance of permit for road transport for safety reasons. They pertain to the carriage by road transport of bulk Motor Spirit having a Research Octane Number of 96 or higher or of bulk Automotive Distillate to some destinations from places of consignment. These destinations are the places within a 40 kilometre radius of the Chief Post Offices of Mildura, Wodonga, Shepparton, Swan Hill, Horsham and Bendigo. Places of consignment are those within a 20 kilometre radius of the Chief Post Offices of Portland, Dandenong and Geelong and the General Post Office of Melbourne. Petroleum transport services to these routes are served by block trains.

It is also the desire of the State Government to ban petroleum tankers on the Tullamarine Freeway, so that products can be transferred to Melbourne Airport by pipeline. Special regulations apply in relation to Barry Beach in Gippsland (which services the offshore oil production platforms), where the Ministry of Transport has ruled that 30% of Automotive Distillate will be moved by rail.

CHAPTER 4

RAIL INVOLVEMENT IN PETROLEUM TRANSPORT

4.1 OVERVIEW

This chapter examines the role of the State Transport Authority (i.e. the Railways) in the provision of petroleum transport. The significance of petroleum transport in the freight operations of rail is analysed, in terms of operating results, market share, and the impact of regulations on petroleum transport.

4.2 OPERATING RESULTS

The competitive situation for the Railways in the provision of petroleum transport is discussed with reference to operating results. The extent of these operating results is limited to the comparison of the quantity of petroleum products delivered by rail versus the non petroleum products transported by rail. The comparison of the levels of rail activity in petroleum transport with the levels of rail activity in non-petroleum transport within

the operation of Victorian Railways (now State Transport Authority, operating under the name V/Line) provide measures of the growing importance of the transport of petroleum products in the freight business of rail.

TABLE 4.1 RAIL'S TRAFFIC OF PETROLEUM* RELATED TO TOTAL RAIL ACTIVITIES ON FREIGHT

YEAR	'000 tonnes			: tonne-kilometres		
	Petr'm	All Goods	%	: Petr'm	All Goods	%
1978-79	388	11,028	3.52	120,892	3,095,929	3.90
1979-80	341	13,325	2.56	109,976	3,846,216	2.86
1980-81	383	12,616	3.04	122,313	3,669,771	3.33
1981-82	400	11,571	3.46	130,432	3,409,985	3.83

Source: Victorian Yearbook (1983).
* includes interstate traffic

The relative contribution of petroleum products to the total freight of Victorian Railways in the recent years is set out in Table 4.1. The Table indicates that in 1981-82, petroleum products accounted for about 3.46% of the total tonnage of all goods carried by Victorian Railways while in terms of tonne-kilometres, petroleum products were 3.83% of all the tonne-kilometres provided. These figures are small but they represent a gradual increase in task since 1979-80, while the volume of the general freight task is on a downward trend. The increase in quantity of petroleum traffic in

rail exhibited in the Table is associated to the increase in the demand of petroleum products in the regions that are served by rail, and to regulatory changes (see below).

Another approximate measure of rail's business on petroleum transport in Victoria was provided in Table 3.3 in Chapter 3. It compares the petroleum products delivered by rail with the consumption of these products in Victoria. Although the Table does not indicate the volume of deliveries for inter and intrastate, it gives a broad estimate of the share of rail. On that basis, rail's share was between 3.47% and 4.11% from 1978-79 to 1981-82.

The present and forecast patterns of petroleum demand has been discussed in Chapter 2. It was noted that the consumption of Motor Spirit exhibits a declining share of forecasted petroleum consumption from Table 2.4 but from actual consumption figures in 1980-81 to 1981-82, Motor Spirit exhibited an increase in share from 57.08% to 57.94% of petroleum consumption. The consumption share of Automotive Distillate has been increasing (Table 2.1A) and it is expected to continue to do so (Table 2.4). In addition, Liquified Petroleum Gas steadily increased its share in petroleum consumption. Therefore, relative growth in the rail transport of petroleum products will occur if the present trend of consumption continues.

4.3 MARKET SHARE

To analyse market share in the movement of petroleum products, it is necessary to take into consideration the quantity of petroleum products hauled by rail for each statistical division. In this way, the distribution and concentration of petroleum transport by rail can be appreciated and at the same time, the market share of rail in petroleum transport in each region can be calculated.

There are no data readily available concerning the quantity of petroleum products delivered by rail to each of the statistical divisions of Victoria. Accordingly , the assistance of V/Line was sought in providing access to raw data. This data was then aggregated and analysed as part of this thesis.

V/Line could only provide the number of tank wagons delivered to towns and cities with rail siding facilities for petroleum products on the condition that the identity of the oil company served in that town or city remains confidential. These data provided by V/Line are summarised in Table C.1 of Appendix C.

There is no standard size of tank wagons used by V/Line for petroleum transport, and since, as noted, the raw data was in terms of number of wagons, the quantity of product delivered by rail to each division could only be an estimate. This estimate was reached by using the average size of the frequently used tank wagon sizes to convert the number of tank wagons into tonnes. The density used in the computation is based on Table 2.1C in Section 2.2.

The quantity of deliveries to each of the towns and cities within the petroleum marketing area of Victoria were also aggregated to give estimates of total deliveries according to statistical division. The use of the average size for the tank wagon and the aggregation of towns and cities according to the statistical division maintained the confidentiality as required by V/Line.

Table 4.2 is derived from the total tonnage delivered to each of the statistical divisions in Tables C.2 and C.3 of Appendix C. Tables in Appendix C are the results of the computations discussed above.

Table 4.2 shows the quantity of petroleum products delivered through rail in Victoria in the two most recent years for which V/Line had data. In 1981-82; North Eastern region received about 40% (97,642 tonnes) of rail's business on petroleum products while the region of Northern Mallee received about 22% (53,660 tonnes) and Goulburn region received 7.48% (18,397 tonnes). Together, these three regions represent about 70% of rail's business on petroleum products in Victoria in 1981-82.

In 1982-83; the North Eastern region received more than 43% (192,350 tonnes) of rail's business on petroleum products, Goulburn region received about 20% (90,306 tonnes) and the region of Northern Mallee received about 15% (65,642 tonnes). These three regions represent about 78% of rail's business on petroleum products in Victoria in that year.

TABLE 4.2 PETROLEUM PRODUCTS DELIVERED BY RAIL IN VICTORIA BY STATISTICAL DIVISION 1981-82 & 1982-83

Statistical Division of Victoria	1981-82 tonnes	1981-82 %	1982-83 tonnes	1982-83 %	% increase
Melbourne	1,155	0.47	1,265	0.28	9.52
Barwon	3,899	1.58	4,700	1.06	20.54
South Western	4,760	1.93	2,630	0.59	-44.75
Central Highlands	20,869	8.48	19,815	4.46	- 5.05
Wimmera	11,113	4.52	5,961	1.34	-46.36
Northern Mallee	53,660	21.81	65,642	14.76	22.33
Loddon Campaspe	24,446	9.93	37,503	8.43	53.41
Goulburn	18,397	7.48	90,306	20.30	390.87
North Eastern	97,642	39.68	192,350	43.25	97.00
East Gippsland	3,668	1.49	13,322	3.00	263.20
Central Gippsland	6,463	2.63	11,255	2.53	74.15
East Central	0	0	0	0	0
Total	246,072	100	444,749	100	80.74

Source: Appendix C

The nearly four-fold growth in the Goulburn region exhibited in Table 4.2 over a one-year period is very substantial. This growth is attributed to the introduction of regular block train services to Shepparton since January 1983.

The overall increase in the business of rail in petroleum products from 1981-82 to 1982-83 of 80.74% is very significant in spite of the decreases in the regions of Wimmera, South Western and Central Highlands. This significant increase in the business of rail is attributed to the Victorian government regulation of transport of petroleum products. The regulation favours the carriage of petroleum products by rail and it took effect in the early part of 1982-83 fiscal year (Victorian Government, 1983).

Taking into consideration the volume of petroleum products delivered by rail against the consumption for each statistical region, the market share of rail to each of the statistical regions could be computed. Table 4.3 represents the percent share of rail transport (relative to petroleum consumption) by statistical division. This is assumed to be very close to the actual market share of rail, since the Table is derived by dividing the quantity of rail delivery by the consumption of each petroleum product in every statistical division. The consumption of petroleum products in each statistical division has been described in section 2.2 (see Table 2.3).

TABLE 4.3 PERCENTAGE SHARE OF RAIL TRANSPORT TO PETROLEUM CONSUMPTION BY STATISTICAL DIVISIONS IN 1981-82

Statistical Division of Victoria	Petroleum Products				
	MS	ADO	FO	LPG	TOTAL
Melbourne	0.001	0.15	0.01	0	0.02
Barwon	0.066	5.38	0	0.05	0.89
South Western	1.462	1.55	0	2.40	1.54
Central Highlands	4.714	19.58	0.84	0	7.47
Wimmera	6.569	5.34	0.89	0	5.33
Northern Mallee	32.683	14.18	8.20	3.49	20.84
Loddon Campaspe	6.341	10.19	1.10	0	6.37
Goulburn	5.733	7.39	1.77	0	5.06
North Eastern	69.054	31.92	6.19	0	49.35
East Gippsland	3.033	1.92	0	0	2.27
Central Gippsland	0.016	10.87	0	0	0
East Central	0	0	0	0	0
				TOTAL	100

Source: Appendix C

As expected, the regions served with block trains experience higher market share for rail. About 69% of Motor Spirit and 32% of Automotive Distillate consumptions of North Eastern region were delivered by rail. There are two cities in this region that are regulated with respect to petroleum product deliveries favouring rail; one is the City of Mildura where the regulation took effect in September 1982 and the other is Swan Hill where the regulation took effect only in June 1983. Regulations for Mildura has shown a notable increase in rail's share from 1981-82 to 1982-83. The effects of regulation for Swan Hill are still unknown at this time, but it is reasonable to expect that regulation will even push the market share of rail in this region higher than the 1981-82 figures.

Table 4.4 is a summary of petroleum products delivered by rail in 1981-82 to 1982-83. In 1981-82, the total tonnage was 246,072 tonnes. This is different from that 400,000 tonnes shown in Table 4.1 earlier in the Chapter. The difference is due to the fact that Table 4.1 dealt with all oil products that included also the interstate deliveries while Table 4.4 deals only with the four major petroleum products transported within Victoria.

Table 4.4 shows that there were substantial increases in the quantity of petroleum products delivered by rail from 1981-82 to 1982-83. The increase in petroleum traffic by rail is attributed to the state regulations imposed favouring rail transport for petroleum distribution in areas served by rail.

TABLE 4.4 PETROLEUM PRODUCTS DELIVERED BY RAIL IN VICTORIA 1981-82 & 1982-83

Petroleum Product	1981-82 tonnes	1982-83 tonnes	Increase %
MS	158,644	263,431	66.05
ADO	82,917	175,739	111.95
FO	2,712	2,751	1.44
LPG	1,799	2,828	57.20
Total	246,072	444,749	80.74

Source: Appendix C

The largest increase of petroleum product delivery by rail was in Automotive Distillate, followed by Motor Spirit. Again, this is because of the government regulations. The Victorian Government (1983) specified the category of petroleum products to be transported by rail to designated destinations. These regulations in essence require that rail be used for deliveries to those destinations of bulk Motor Spirit having a researh octane number of 96 or higher and of bulk Automotive Distillates. Furthermore, it is specific in the regulations that 30% of Automotive Distillate (diesel engine fuel) for Barry Beach in the Central Gippsland region should be moved by rail from September 1982. This particular regulation for Barry Beach favouring rail transport made the quantity of ADO delivered by rail in the Central Gippsland to

increase by 74.15% (Table 4.2) from 1981-82 to 1982-83.

The general increase of the market share of rail of 80.74% is well above the projected growth rate on the consumption of petroleum products of 2.00% as noted in Table 2.4 of Chapter 2. The increase of the quantity delivered by rail is not related to the increase in the demand of petroleum products in Victoria because the increase in market share of rail is very much higher than the projected growth rate of petroleum consumption. The increase in market share of rail in petroleum transport therefore is mostly attributed to the government intervention and to some extent in the business strategies of V/Line.

4.4 IMPACT OF REGULATORY ENVIRONMENT

Regulations are used in Victorian petroleum transport to perform basically two functions. First is to achieve and maintain operational safety and second is to influence the distribution of traffic.

As far as engineering design is concerned, most safety requirements for rail vehicles and associated equipments used for petroleum transport are satisfied by adherence to the ROA's Dangerous Goods Code.

The main rationale behind the policy made by the Minister of Transport concerning destinations where road transport shall not be used is related to safety (Victorian Government, 1983). Where destinations are served by rail transport, the intention is to cause

the transport of dangerous goods (including petroleum products) to be undertaken by rail to the maximum extent possible, in the interest of the safety of other users of the Victorian road system and the people of the country towns through which such vehicles currently pass. Road transport of petroleum products is considered as a road hazard because of the potentially disastrous effects of accidents involving petroleum products.

It is difficult to establish whether road is in fact safer than rail, because there are no studies confirming that rail transport of petroleum products is relatively safer than road transport in Victoria. Further research would seem to be appropriate here. Perhaps the theory of regulation proposed by Stigler (1975) is more applicable. Stigler insists that regulation serves the private interests of politically effective groups; in this case, they are the many road users who are afraid of the presence of road tankers on the road they are using. These groups of people have the voting power. They have the prerogative to ask for some sort of protective legislation from their politicians. Hence regulations against road transport of goods which are perceived to be dangerous. Moreover, other influential groups (V/Line and its unions) perceive a benefit to them in such regulations.

Another probable reason for this regulation is to enable the state government to attempt to reduce the rail deficit. Gannon (1978) affirmed that the order of magnitude and rate of growth of railway's deficit places a very large burden on the state government. An increase in the market share of rail in petroleum

transport will generate revenues that will offset some of the state government's subsidy in the general operation of the Railways.

The increase in the volume of petroleum traffic by rail noted earlier in Table 4.2 and Table 4.4 are mainly attributed to the restrictions imposed on road tankers. In effect, the regulation is gradually carrying out the intention of the government that more petroleum products should be delivered by rail and less by road mode.

As noted in Chapter 2, freight costs to country areas are subsidised to make users of petroleum products in country areas at a lesser disadvantage than their city counterpart with respect to the final petroleum price. However it could be argued that the long run effect of the Commonwealth Freight Subsidy Scheme may be counter-productive. There are several reasons for this. First, the freight subsidy scheme partially reimburses oil companies for their transport costs. This subsidy provides no incentive to reduce costs since to do so will lead to lower subsidies. Companies have only a limited interest in reducing the remaining components of transport cost. Indeed, freight subsidy invites cost "padding".

Second, the freight subsidy scheme can operate to the disadvantage of rail in that it encourages alternative long distance carriers who might be uncompetitive with rail. The submissions of VicRail to the V.T.S. (1980) claimed that rail freight cost was lower than road freight cost for distances in excess of 300 kilometres. Beyond that distance, rail begins to be more favourable

to use than road. Where road and rail are in competition, the subsidy scheme favours the road transport of petroleum products from seaboard bulk terminal to retailer or consumer. This is because almost all of the cost of the road transport are included in the computation of the subsidy. (Michael and Ogden, 1984)

CHAPTER 5

CONCLUSION

1. The main petroleum products used in Victoria are Motor Spirit, Automotive Oistillate, Fuel Oil and LPG. These products account for about 90% of the oil products consumed in Victoria. On the basis of the 1980-81 to 1981-82 consumption pattern; there is a growth in consumption except for Fuel Oil.

2. The decreased demand for Fuel Oil was expected, but the size of the fall (11.2%) was greater than anticipated. This huge decrease could be attributed to two causes. First, the switching of Fuel Oil users to other fuels such as to Automotive Distillate and second, the absolute reduction in demand of Fuel Oil as a result of some improvements in the technology of fuel utilisation.

3. The growth in the consumption of LPG by 24.18% is associated with the general expansion of its usage. Some users of Motor Spirit have switched to LPG (for example, Taxi Cabs). Inspite of fuel switching, the consumption of Motor Spirit continued to increase by 3.65%.

4. There is a need for an updated forecast on the demand of petroleum products because the actual consumption pattern from 1979-80 to 1981-82 is different from the trend in the forecast made by DNDE (1981). Exact projections are impossible but the forecast must be within a viable range of variations. Forecast of the demand for petroleum products are needed to assist planning and policy simulation.

5. The consumption of petroleum products in the population related activities account for more than 89% of petroleum product consumed. The agricultural sector consumed only 6.42%, while the manufacturing sector used 4.53% of the entire petroleum products consumed in Victoria in 1981-82.

6. Population related activities are concentrated in major urban areas of Victoria. The demand for petroleum products in the statistical division of Melbourne is about 66% of the entire consumption in Victoria. Second to Melbourne is Barwon region with a share of around 5% of the state's consumption. Outside these regions of Melbourne and Barwon, there are about a dozen widely dispersed secondary population centres which account for the remaining 30% of petroleum product consumption.

7. Petroleum products are delivered in areas where they produce the needed utilities. They are generally moved from the refineries to the tank farms or seaboard bulk storage installations, then to the final end users or retailers. The quantity of petroleum products hauled (made equal to the

consumption figures) in 1981-82 was 8,800,000 tonnes. Rail carried about 2.80% (246,072 tonnes but this figure increased to 444,740 tonnes in 1982-83). Sea transport carried about 2% (173,000 tonnes) that is, if the volume of petroleum product movement by sea as recorded by the Department of Transport (1983) are wholly taken as petroleum products in the same way as defined in this study; but most probably, the figure reported includes other oil products. Excluding double handling by road transport (i.e. movement from regional distribution centres to the end users), the share of road in petroleum transport is about 95% of the total consumption, most of these were short distance hauls.

8. Road transport is flexible and is well suited for small volume and short distance haulage. This causes the distinct role of road transport for the deliveries of petroleum products from distribution centres to the end users even in small quantities. Rail transport is more favourable for large volume and long distance movements of petroleum products.

9. The regions of Melbourne and Barwon draw a large proportion of the demand of petroleum products. Furthermore, Victorian refineries are situated in these regions. Therefore these two regions are not generally a prospect for rail transport, but they are generally suited for road transport to perform the petroleum transport task.

10. The principal role of rail in the petroleum transport is in

supplying the bulk needs of the regional distribution cetres. The Victorian government has encouraged rail in this role by the introduction of road restrictions on petroleum transport to the distibution centres in Mildura, Wodonga, Shepparton, Swan Hill, Horsham and Bendigo. It is from these regional centres that road delivery systems for petroleum products radiate.

11. The volume of rail petroleum traffic has been increasing at a faster rate than the general freight movements. This high rate of increase in petroleum transport share is attributed to the business strategies of V/Line (i.e. introduction of block train services) as well as to the enforcement of the government's regulations on the transport of petroleum products.

12. Finally, there is a need for further research in connection with the safety issues in the carriage of petroleum products.

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APPENDIX A

CONSUMPTION OF PETROLEUM PRODUCTS BY END USERS

Details on the dispersion of petroleum products by statistical division by end user are needed to explain the distribution of petroleum products and the uses to which petroleum products are put.

Due to the absence of data on the consumption by end users for 1981-82, the forecast of the DNDE for that year was taken. Table 5.30 in pages 105-107 of DNDE (1981) was restructured to highlight the consumption of the four major petroleum products and to determine the major end users of these petroleum products. As a result of this, Table A.1 was formed. This table shows the forecasted energy for each petroleum product to be used by the end users.

Taking Automotive Distillate (ADO) as an example from Table A.1, a total of 50.3 petajoules will be used for 1981-82; where 18.4 petajoules will be utilised by Agriculture, 0.8 petajoule by Manufacturing, none for Electricity/Gas/Water, 3.3 petajoules for Construction, 25.7 petajoules for Transport and 2.1 petajoules for other small groups of end users.

Table A.2 is derived by converting the consumed energy in petajoules for each petroleum product into percentage. For example, instead of 50.3 petajoules at 100% for ADO, the breakdown would be in percentage as follows: 36.58% for Agriculture, 0.02% for Manufacturing, 0% for Electricity/Gas/Water, 0.07% for Construction, 51.09% for Transport, and 12.24% for other small groups of end users.

Actual consumption of petroleum products, in thousand tonnes, in 1981-82 are shown in Table 2.1B. Taking again ADO as an example, the 1537 thousand tonnes of ADO in Table 2.1B will be subdivided to each end users according to the percentages of Table A.2. Similarly; Motor Spirit (MS), Fuel Oil (FO), and LPG will also be distributed in the same manner that ADO was subdivided. The summary of the process is Table A.3.

Table 2.2 is derived by re-grouping the end user sector into three sectors: Population Related Activities (P.R.A.), Agriculture, and Manufacturing. Figures under the P.R.A. category are the summation for Transport, Electric/Gas/Water, Construction and other sectors different from Agriculture and Manufacturing.

Table A.4 is derived by using the quantity of each of the petroleum products consumed by P.R.A. as recorded in Table 2.2 and subdividing them according to the population distribution. For example, for the Melbourne region; MS is 4101 which is 71.07% of 5770, ADO is 692.55 which is 71.07% of 974.46, etc..

Table A.5 is derived by using the quantity of each of the petroleum products consumed in Agriculture as recorded in Table 2.2 and subdividing them according to percentage distribution based on the occupied area of agricultural land in each statistical division. For the Melbourne region; ADO is 10.57 which is 1.88% of 562.23 and LPG is 0.05 which is 1.88% of 2.52, etc.. There are no MS and FO used in agriculture.

Table A.6 is derived by using the quantity of each of the petroleum products consumed in Manufacturing as recorded in Table 2.2 and subdividing them according to the percentage distribution based on the amount of petroleum products used in Manufacturing. For the Melbourne region; ADO is 0.174 which is 56.21% of 0.310, FO is 25.72 which is 56.21% of 45.75, etc.. There is no MS used in the manufacturing industries.

Table 2.3 is derived by adding figures from Table A.4, A.5 and A.6. For example, the total consumption of MS in the Melbourne statistical division is equal to the summation of all the MS consumed in the Melbourne region by P.R.A., Agriculture and Manufacturing as registered in Tables A.4, A.5, and A.6 respectively. Likewise, the total consumption of ADO for the Melbourne region will be equal to the summation of all ADO consumed in the Melbourne region by P.R.A., Agriculture and Manufacturing. This computation is repeated for all the major petroleum products for each statistical division; and Table 2.3 is the summary of the entire computations.

TABLE A.1 CONSUMPTION OF PETROLEUM PRODUCTS BY END USER VICTORIA 1981-82

Petroleum Product Category	Consumption by End User Sector in petajoules						
	Agri.	Manuf.	El,Gas	Constr.	Transport	Other*	Total
Motor Spirit	-	-	-	-	142.9	-	142.9
ADO	18.4	0.8	-	3.3	25.7	2.10	50.3
Fuel Oil	-	1.8	5.9	0.1	16.3	0.50	24.6
LPG	0.05	6.9	-	-	6.0	4.05	17.0

Source: Department of National Development and Energy (1981).
* includes Wholesale/Retail, Public Administration, Community Services, Entertainment, Domestic, etc.

TABLE A.2 CONSUMPTION OF PETROLEUM PRODUCTS BY END USER VICTORIA 1981-82

Petroleum Product Category	Consumption by End User Sector in percent						
	Agri.	Manuf.	El,Gas	Constr.	Transport	Other*	Total
Motor Spirit	-	-	-	-	100	-	100
ADO	36.58	0.02	-	0.07	51.09	12.24	100
Fuel Oil	-	7.32	23.98	0.41	66.26	2.03	100
LPG	0.29	40.59	-	-	35.29	23.83	100

Source: Table A.1
* includes Wholesale/Retail, Public Administration, Community Services, Entertainment, Domestic, etc.

TABLE A.3 CONSUMPTION OF PETROLEUM PRODUCTS BY END USER
VICTORIA 1981-82

Petroleum Product Category	Consumption by End User Sector in '000 tonnes						
	Agri.	Manuf.	El,Gas	Constr.	Transport	Other	Total
Motor Spirit	-	-	-	-	5770	-	5770
ADO	562.23	0.31	-	1.08	785.25	188.13	1537
Fuel Oil	-	45.75	149.87	2.56	414.13	12.69	625
LPG	2.52	352.32	-	-	306.32	206.84	868
Total	564.75	398.38	149.87	3.64	7275.70	407.66	8800
%	6.42	4.53	1.70	0.04	82.68	4.63	100

Source: Table A.2

TABLE A.4 CONSUMPTION OF PETROLEUM PRODUCTS OF POPULATION RELATED ACTIVITIES 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Population*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	71.07	4101	692.55	411.67	364.70
Barwon	5.02	290	48.92	29.08	25.76
South Western	2.53	146	24.65	14.66	12.98
Central Highlands	3.03	175	29.53	17.55	15.55
Wimmera	1.39	80	13.54	8.05	7.13
Northern Mallee	1.86	107	18.12	10.77	9.54
Loddon Campaspe	3.81	220	37.13	22.07	19.55
Goulburn	3.38	195	32.94	19.58	17.34
North Eastern	2.02	116	19.68	11.70	10.37
East Gippsland	1.46	84	14.23	8.46	7.49
Central Gippsland	3.39	196	33.03	19.64	17.41
East Central	1.04	60	10.14	6.02	5.34
TOTAL	100	5770	974.46	579.25	513.16

* based on the population in each statistical division

TABLE A.5 CONSUMPTION OF PETROLEUM PRODUCTS OF AGRICULTURAL ESTABLISHMENTS 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Victoria*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	1.88	-	10.57	-	0.05
Barwon	3.48	-	19.57	-	0.09
South Western	12.63	-	71.01	-	0.32
Central Highlands	6.07	-	34.13	-	0.15
Wimmera	16.83	-	94.62	-	0.42
Northern Mallee	18.21	-	102.38	-	0.46
Loddon Campaspe	11.24	-	63.19	-	0.28
Goulburn	10.49	-	58.98	-	0.26
North Eastern	5.84	-	32.83	-	0.15
East Gippsland	7.86	-	44.20	-	0.20
Central Gippsland	4.65	-	26.14	-	0.12
East Central	0.82	-	4.61	-	0.02
TOTAL	100	0	562.23	0	2.52

* from Victorian Yearbook (1983), based on the area of agricultural land used in each statistical division

TABLE A.6 CONSUMPTION OF PETROLEUM PRODUCTS OF MANUFACTURING INDUSTRIES 1981-82 ('000 TONNES)

Statistical Division of Victoria	Percent of Victoria*	Petroleum Products			
		MS	ADO	FO	LPG
Melbourne	56.21	-	0.174	25.72	198.04
Barwon	5.66	-	0.017	2.59	19.94
South Western	9.79	-	0.030	4.48	34.49
Central Highlands	1.88	-	0.006	0.86	6.62
Wimmera	1.23	-	0.004	0.56	4.33
Northern Mallee	2.30	-	0.007	1.05	8.10
Loddon Campaspe	5.42	-	0.017	2.48	19.10
Goulburn	9.88	-	0.031	4.52	34.81
North Eastern	1.79	-	0.006	0.82	6.32
East Gippsland	0.99	-	0.003	0.45	3.49
Central Gippsland	2.34	-	0.007	1.07	8.24
East Central	2.51	-	0.008	1.15	8.84
TOTAL	100	0	0.310	45.75	352.32

* from A.B.S. (1982b), based on the amount of all petroleum products used in the Manufacturing Industries in each statistical division.

APPENDIX B

INCIDENCE OF FREIGHT RATES

Following the system used by Taplin (1982) in illustrating the incidence of freight rates; the reference point in assessing the incidence of freight rates is the price-quantity equilibrium that would be reached if transport were costless. The deviations of the price of petroleum products from the tank farms of the oil company and the price paid by consumers from the notional price represent the oil company's and the consumers' shares of the freight plus some transaction costs.

If supply and demand functions are linear then the freight charges are met by the oil company and consumers in inverse proportion to the slopes. Since the ratio of the elasticities at the equilibrium point in the notional freight-free market is equal to the ratio of the slopes, this also means that the incidence of freight rate is inversely proportional to these point elasticities.

The supply elasticity of Motor Spirit (as a manufactured commodity) may be assumed to be greater than the absolute value of its demand elasticity. Using these relative values, an illustration on the incidence of freight rate is possible as shown in Figure B.1. The figure portrays that most of freight charges fall on the

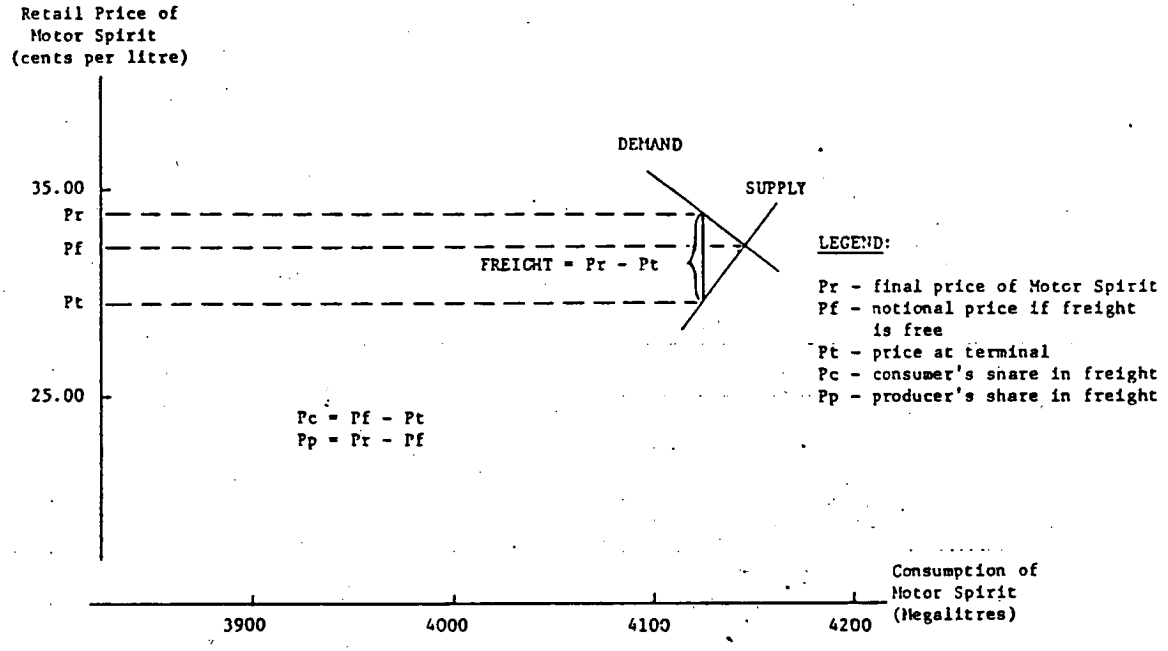

Figure B.1 Incidence of Freight Rate on Motor Spirit

consumers and less on the oil company.

In algebraic terms, the expression is

$$\frac{Pc}{Pp} = \frac{Es}{Ed} \qquad (1)$$

where: Pc is the consumers' share in the freight rate,

Pp is the producer's share in the freight rate,

Es is the elasticity of supply for motor spirit,

and Ed is the elasticity of demand for motor spirit (disregarding the sign).

The freight rate F passed on to the consumers and producer is:

$$F = Pc + Pp \qquad (2)$$

From equation (1);

$$Pc = \frac{Es}{Ed} Pp \qquad \text{or} \qquad Pp = \frac{Ed}{Es} Pc ,$$

so that the freight rate F in terms of Pp is

$$F = Pp + \frac{Es}{Ed} Pp \qquad \text{or} \qquad \frac{Pp}{F} = \frac{1}{\left(\frac{Es}{Ed} + 1 \right)}$$

and the freight rate F in terms of Pc is

$$F = \frac{Ed}{Es} Pc + Pc \qquad \text{or} \qquad \frac{Pc}{F} = \frac{1}{\left(1 + \frac{Ed}{Es} \right)} .$$

As assumed earlier, the absolute value of Ed is less than Es.

Therefore,

$$\frac{1}{\left(1 + \frac{Ed}{Es}\right)} \text{ is greater than } \frac{1}{\left(\frac{Es}{Ed} + 1\right)}.$$

In which case,

$$\frac{Pc}{F} > \frac{Pp}{F}$$

In words, the share of the consumers to the freight rate is greater than the share of the producer of motor spirit.

APPENDIX C

PETROLEUM PRODUCTS DELIVERED BY RAIL

There are no standard sizes for rail tank wagons used by V/Line for petroleum transport. From eleven different sizes used frequently, ranging from 38,369 litres to 45,916 litres, the average size used here is taken to be 43,000 litres.

Some destinations are served by "jumbo" wagons. The capacity of each of these jumbos is 68,200 litres. At present, there is only one Oil Company that uses these jumbos, so that using the size of a jumbo to a particular destination would identify the volume carried for that Oil Company.

To maintain the confidentiality of the share of the market within the oil industry (as required by V/Line), two measures were taken into account. First, only one size of tank wagon is used in the calculations throughout. The size used is 43,000 litres per wagon. And second, the quantity of deliveries to each of the towns and cities within the petroleum marketing area of Victoria are aggregated according to statistical divisions.

The conversion factor used for a 43,000 litre tank wagon depends on the density of the petroleum products carried as discussed in section 2.2. Using the typical conversion factors adopted from Table 2.1C, the net masses of petroleum products for a 43,000 litre tank wagon are: 31.85 tonnes for Motor Spirit; 36.13 for tonnes for Automotive Distillate; 38.74 tonnes for Fuel Oil; and 23.37 tonnes for L.P.G..

Table C.1 shows the number of tank wagons delivered by rail to some destinations in the recent years. Taking the sum of delivered wagons of petroleum products to each statistical division and converting them into tonnes produces Table C.2 for 1981-82 and Table C.3 for 1982-83.

Table 4.2 is derived from the total tonnes delivered to each of the statistical divisions of Table C.2 and Table C.3.

Table 4.3 is derived from Table C.2 and Table 2.3 in Chapter 2. Numbers in Table 4.3 are derived by taking the delivery of a particular petroleum product to a statistical destination in Table C.2 and dividing it by the consumption of that product in the same statistical division from Table 2.3.

Table 4.4 shows the sum of each category of petroleum products delivered in 1981-82 and 1982-83 from Tables C.2 and C.3.

TABLE C.2 PETROLEUM PRODUCTS DELIVERED BY RAIL IN VICTORIA 1981-82 (in tonnes)

Statistical Division of Victoria	Petroleum Product Category				
	Motor Spirit	ADO	Fuel Oil	LPG	Total
Melbourne	32	1,084	39	0	1,155
Barwon	191	3,685	0	23	3,899
South Western	2,134	1,481	0	1,145	4,760
Central Highlands	8,249	12,465	155	0	20,869
Wimmera	5,255	5,781	77	0	11,113
Northern Mallee	34,971	17,089	969	631	53,660
Loddon Campaspe	13,950	10,225	271	0	24,446
Goulburn	11,179	6,792	426	0	18,397
North Eastern	80,103	16,764	775	0	97,642
East Gippsland	2,548	1,120	0	0	3,668
Central Gippsland	32	6,431	0	0	6,463
East Central	0	0	0	0	0
Total	158,644	82,917	2,712	1,799	246,072

Source: TABLE C.1

TABLE C.3 PETROLEUM PRODUCTS DELIVERED BY RAIL IN VICTORIA 1982-83 (in tonnes)

Statistical Division of Victoria	Petroleum Product Category				
	Motor Spirit	ADO	Fuel Oil	LPG	Total
Melbourne	0	1,265	0	0	1,265
Barwon	0	4,661	39	0	4,700
South Western	350	434	0	1,846	2,630
Central Highlands	8,950	10,478	387	0	19,815
Wimmera	2,962	2,999	0	0	5,961
Northern Mallee	41,660	22,690	310	982	65,642
Loddon Campaspe	24,142	12,935	426	0	37,503
Goulburn	57,967	31,758	581	0	90,306
North Eastern	117,686	73,850	814	0	192,350
East Gippsland	9,587	3,541	194	0	13,322
Central Gippsland	127	11,128	0	0	11,255
East Central	0	0	0	0	0
Total	263431	175739	2751	2828	444749

Source: TABLE C.1